CLIMAS

Southwest Climate Outlook

Monthly Climate Packet
February 2004

Climate Assessment for the Southwest
Institute for the Study of Planet Earth
University of Arizona
PO Box 210156
Tucson, Arizona 85721-0156
(520) 792-8712

TABLE OF CONTENTS

Section A

BACKGROUND

CLIMAS
Southwest Climate Outlook

February 2004

THE UNIVERSITY OF ARIZONA®

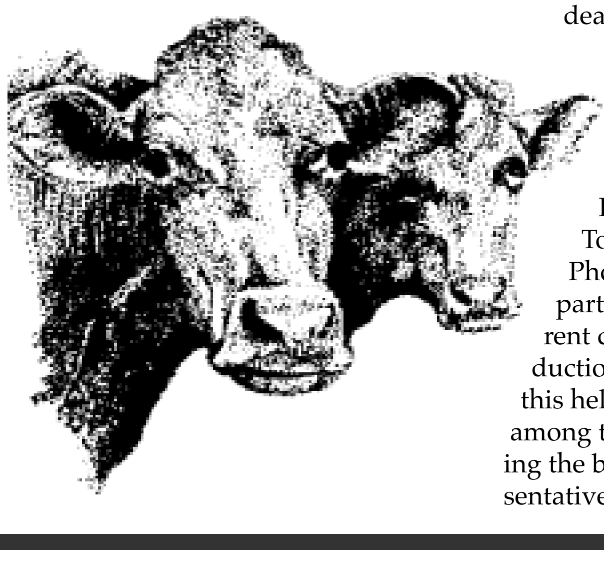
Ranchers split on supporting grazing permit buyout

BY MELANIE LENART

With drought withering the landscape and government regulations increasingly cutting into profits, some ranchers are supporting a plan that would allow a one-time buyout of cattle-grazing permits on federal lands.

More than 165 Arizona ranchers support a bill introduced into Congress by Rep. Raúl Grijalva (Arizona District 7) to pay ranchers $175 per "animal unit month" to retire their grazing permits on federal lands. One animal unit month is equivalent to a cow and her calf grazing for one month, so a rancher who typically has grazed 100 cow-calf pairs for six months of the year would gain $105,000 in the one-time-only deal, if the bill were approved by Congress. The bill has been assigned to committees for study.

Grijalva's bill (House Resolution 3337) suggests that Arizona serve as the pilot project for a grazing permit buyout. In addition, he has supported an earlier bill (H.R. 3324) that would provide a similar opportunity to other ranchers across the nation.



Grijalva cited the ongoing drought and the fact that ranchers and environmentalists worked together to come up with the plan as two good reasons for starting a program in Arizona.

"Many ranchers in Arizona are suffering financially because of the changing economics in cattle production, but also because of environmental changes. The drought is requiring them to reduce livestock numbers on the land, and some simply cannot make a living," the congressman stated.

Researchers on the Climate Assessment for the Southwest (CLIMAS) project found that the four-year cool-season precipitation average from 1999–2002 was the worst in the instrumental record, with the period from 1901–1904 ranking second and 1954–1957 ranking fourth. The period at the beginning of the 20th century spelled disaster for ranchers at the time, some of whom took to selling the bones of dead cattle for fertilizer to get by (Bahre and Shelton, 1996), and some modern ranchers still remember the struggles caused by the 1950s drought.

Ranchers who depend on the Tonto National Forest near Phoenix for ranching have been particularly hard-hit by the current drought and the required reductions in cattle grazing. Perhaps this helps explain the predominance among the nine ranchers spearheading the buyout plan along with representatives from several environmental groups on the Arizona Grazing Permit Buyout Campaign. John Whitney IV, campaign chairman and part of the family-owned Circle Bar Ranch just outside Phoenix, said the U.S. Department of Agriculture Forest Service's response to the drought is threatening to put many ranchers out of business.

Right now, only 3 percent of the cattle permitted for grazing on the Tonto National Forest are actually occupying the land, according to Buck McKinney, range conservationist for the Tonto. The drought has reduced vegetation cover, causing the Forest Service to limit cattle grazing. But in some cases, ranchers themselves have made the decision not to graze cattle on the Tonto, McKinney said.

Whitney challenged the notion that the ranchers had a choice in the reduction in cattle-grazing numbers.

"These are not hobby ranchers. They ranch for a living. So why would they not put cattle on the land if they could?" he asked rhetorically.

The Circle Bar Ranch has been restricted from putting any cattle on its allotment for several years because of the drought, Whitney said. In addition, they have been notified that they will only be allowed to graze about half of the usual 1,250 cow-calf pairs when they do get the green light to start grazing again, he said.

"The ranchers look at it as, 'If you're going to cut my cattle in half, you're going to put me out of business,' " he said. He compared the ranchers' frustration to that of car dealers trying to

continued on page 2

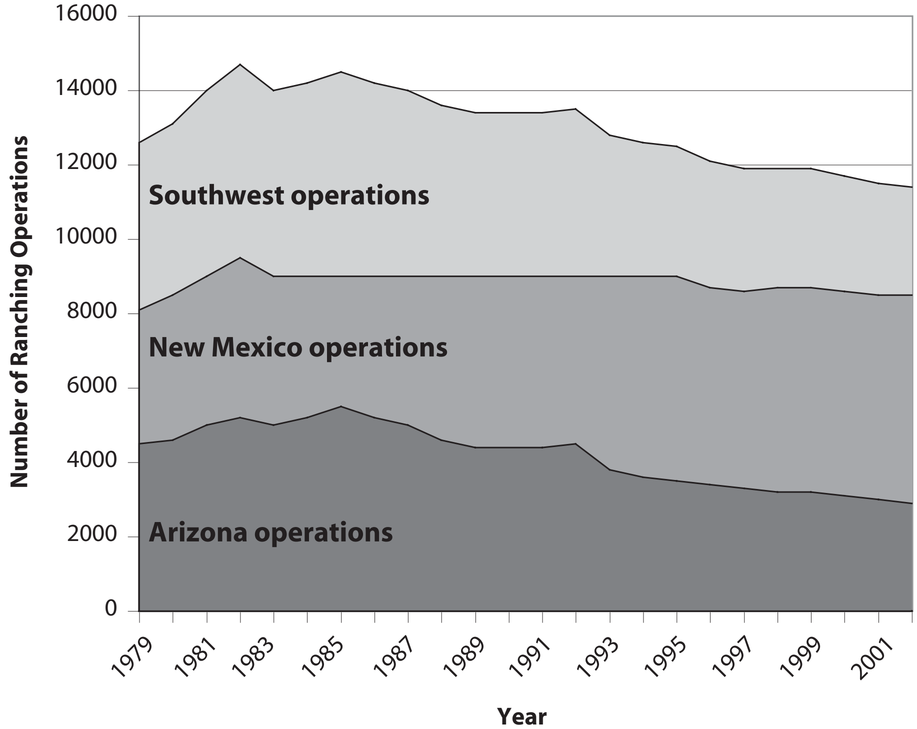


Figure 1. The total number of ranching operations in the southwestern states of Arizona and New Mexico has been declining in recent years. The early to mid-1980s represented a peak in ranching operations for the Southwest during this time frame, 1979—2002. Data were gathered from the National Agricultural Statistics Service website.

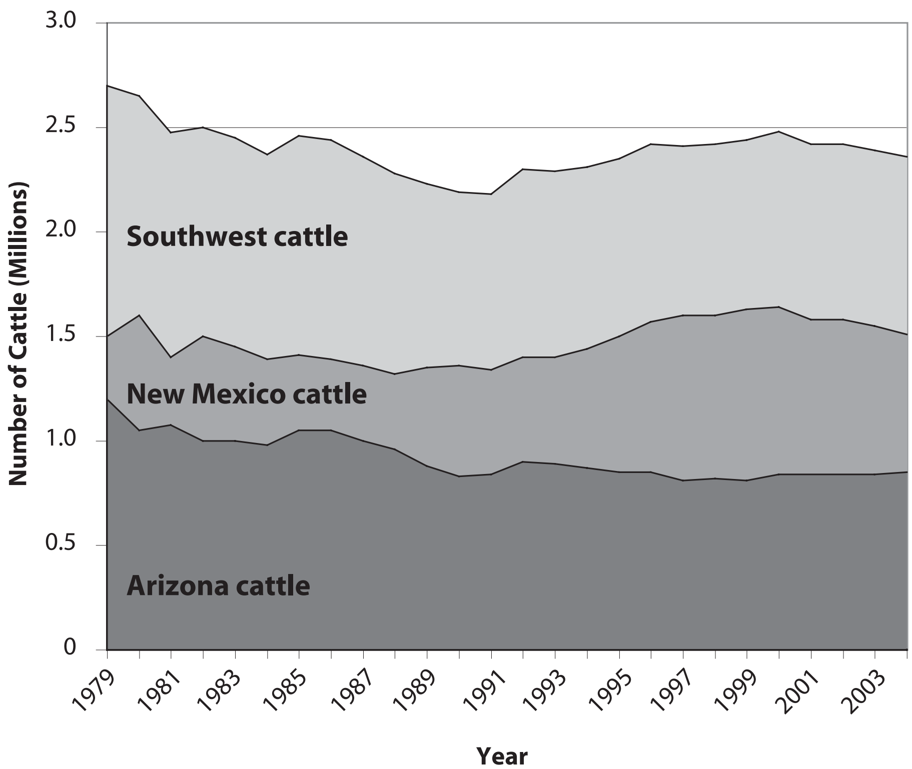


Figure 2. The number of cattle in Arizona has declined since 1992, with some of this drop attributable to drought impacts on the landscape. In New Mexico, the number of cattle was lower during much of the 1980s than in more recent years, but numbers began to drop again in the year 2000. Data were gathered from the National Agricultural Statistics Service website.

Permit buyout, continued

make a living while being told how many cars they can sell each year.

Forest Service policy and management practices for grazing allotments irked many of the roughly 50 Arizona ranchers surveyed between 1998 and 2002 by researchers for CLIMAS, the University of Arizona group that produces the Southwest Climate Outlook, among other activities. The surveyed ranchers indicated they rarely viewed drought as a primary motivation for ranch sales, but rather saw government regulations as the main culprit.

The number of ranching operations dropped by 17 percent in Arizona and by about 6 percent in New Mexico from 1995 to 2002 (Figure 1), according to data from the National Agricultural Statistics Service (NASS). In Arizona, the drop occurred in all size classes, so consolidation of ranches into larger units would not explain the decrease. Similarly, in New Mexico, the decline occurred mainly in larger operations, while the number of operations with less than 50 heads of cattle increased slightly.

In addition, Arizona ranchers increased the number of cattle on supplemental feed by 45 percent while the total number of cattle dropped by 1 percent for that same time period (1995–2002), according to NASS figures (Figure 2). In New Mexico, the proportion of cattle on supplemental feed actually declined by 30 percent during that time frame, while the total number of cattle increased by about 5 percent. However, the number of cattle in New Mexico dropped by about 6 percent between 1998 and 2004, and were generally lower during the 1980s, so timing of severe agricultural drought impacts probably differed in the two southwestern states.

Although the proposed buyout bill frames the current ranching woes in the context of the drought, a spokesperson for the Arizona Cattle Growers Association (ACGA) considers dealing with drought all in a day's work.

"It's the same as it's always been. The livestock people all over the world have spent their whole life dealing with drought," maintained ACGA Natural Resources Director Charles "Doc" Lane. "We believe in raising fat, contented animals. If you depend on the land and the climate, the only way to raise fat, contented animals is to have fewer of them during the drought."

The association opposes the grazing permit buyout plan, putting dozens of individual ranchers in the unusual position of agreeing with environmentalists more than their fellow ranchers who run the ACGA.

During a recent phone call, Lane expressed the Association's stance that ranchers who are suffering financially should sell their ranch to others who will carry on the ranching tradition. "If I sell a ranch during a drought, chances are someone will come along and buy it because they know the drought will break sometime," he added.

Meanwhile, Lane feared that retiring ranching permits would threaten the rural lifestyle that ranchers love, would reduce regional food security, and would challenge the Forest Service's traditional "multiple use" of forests.

Forest Service land managers have been responding to a push from many members of society to consider issues of water quality, fire hazards, and recreational values of forests when designing plans for their "multiple use," which traditionally have involved timber harvesting, mineral extraction, and cattle grazing.

"The point is we can't just have a place to play. We have to have a place to produce goods and services," he said, adding that Phoenix's local food supply would run out in seven days were it not for continual replenishment. "If disaster struck, and importation of food from other parts of the nation cannot occur, in eight days the people of Phoenix are fighting over the last of the food. But on Day Eight you cannot say, 'OK, we have decided we do need to produce food.' "

The buyout campaign chairman challenged the contention that continued ranching on federal lands would help guarantee an ongoing food supply in an emergency.

"The cows produced in Arizona wouldn't provide for anybody very long," Whitney noted.

The ranchers also disagree on which approach, business as usual or a paid-off retirement of grazing permits, would be more likely to encourage development of rural areas via subdivision of ranches.

Only 3 percent of the nation's beef producers hold federal grazing permits, said Daniel Patterson, an ecologist with the Center for Biological Diversity (CBD) in Tucson. The center has a representative on the campaign steering committee headed by Whitney, and a CBD meeting with Phoenix ranchers in August 2002 helped launch the Arizona grazing permit buyout proposal.

"Drought is a climate reality in the Southwest, and it will be an issue in the future because it certainly affects the permittees and the land. Some of them have been more supportive of the buyout because of the desertification," Patterson said.

Meanwhile, private conservation groups have already successfully bought grazing permits from permittees to protect the desert tortoise in California's Mohave National Preserve, Patterson said. But he noted that grazing changes proposed late last year by the Bush administration would threaten such solutions.

"It's important to have Congress weigh in on this solution and stop the Bush administration from derailing a win-win buyout solution to end public lands ranching conflicts," Patterson said. The CBD expects to devote a full-time staff member to this project for years to come, if necessary, he said. Despite agreement between some ranchers and environmentalists, the disagreement within the ranching community promises to make this an issue of contention that eludes a quick fix. The conflict does serve to illustrate, however, how drought can aggravate existing societal tensions over resources.

The complexity of balancing economic and cultural values with riparian conservation and fire management values on public lands becomes all the more apparent during times of drought. Although it may be unrealistic to expect a simple solution that receives universal support, it seems clear that drought will provoke discussions that would otherwise be relegated to the back burner, including the issue of cattle grazing on public lands.

Related Links and Papers

As part of the "Reconstructing Past Climate in the Southwest" project, the CLIMAS website provides instrumental records for 1896–2002 and tree-ring records to reconstruct cool-season precipitation for 1000–1896. An online tool to access this data is available at http://www.ispe.arizona.edu/climas/research/paleoclimate/product.html.

The National Agricultural Statistics Service compiles a variety of data related to ranching. The database can be searched for specific data by selecting "U.S. and State Data" and then "Cattle" from the following website: http://www.nass.usda.gov:81/ipedb/.

The Arizona Grazing Permit Buyout Campaign website allows cattle and sheep ranchers to calculate their possible compensation for a grazing permit buyout, and lists ranchers who publicly support the campaign, among other features. http://www.azbuyout.org/buyout/cont.htm.

Bahre, C. J., and M. L. Shelton. 1996. Rangeland destruction: Cattle and drought in southeastern Arizona at the turn of the century. *Journal of the Southwest*, 38(1):1–22.

Monthly Climate Summary - February 2004

Highlights

Hydrological Drought – Hydrological drought continues in the Southwest.

- All New Mexico reservoirs are at well below average levels, although small gains have been made at Elephant Butte reservoir.
- Storage in the major Colorado River reservoirs is still below average and continues to fall.

Precipitation – Recent precipitation should bring short-term drought relief to Arizona and northern New Mexico. Water year precipitation for most of the Southwest is still below average. Since January 2004, there have been increases in precipitation and percent of average snow water content. However, snowpack is still quite low for this time of year for most of Arizona and New Mexico.

Temperature – During the past 30 days, temperatures have been below average across the Southwest. Last month's temperature outlook did not anticipate below-average temperatures across our region.

Climate Forecasts – Seasonal forecasts indicate considerably increased probabilities of above-average temperatures across Arizona and New Mexico through the spring and summer months. Precipitation forecasts do not suggest strong probability anomalies for either above- or below-average precipitation. The U.S. Drought Outlook suggests improvement in drought conditions for Arizona and northern New Mexico.

ENSO – There is a slightly better-than-average chance of a weak El Niño episode developing in 2004, but ENSO conditions will likely remain neutral during the first half of 2004.

The Bottom Line

In the absence of exceptional precipitation during the next month, hydrological drought will persist in the Southwest.

- The **most likely scenario** is that, despite recent precipitation in the Southwest, there is no indication that most of the Southwest will receive drought-ending precipitation during the next several months. Multi-year soil moisture deficits make it difficult to anticipate the effects of above-average precipitation and snow in northern New Mexico and the Upper Rio Grande Basin. Recent precipitation events will help delay the onset of the fire season. The effects of above-average precipitation in parts of the Upper Colorado River Basin will not be felt until snowmelt during late spring and early summer.
- The **worst case scenario** is that the storms tracking across the Southwest do not yield substantial precipitation. A return to above-average (long-term trend) temperatures, combined with low-yield precipitation, would result in continued soil moisture and reservoir depletion by the beginning of summer 2004. In Arizona, neutral ENSO conditions most often result in below-average precipitation.
- The **best case scenario** is that short-range forecasts for continued storminess in the Southwest are correct and result in substantially increased mountain snowpack. The probability of La Niña and exceedingly dry conditions developing is exceedingly low, and that's good news!

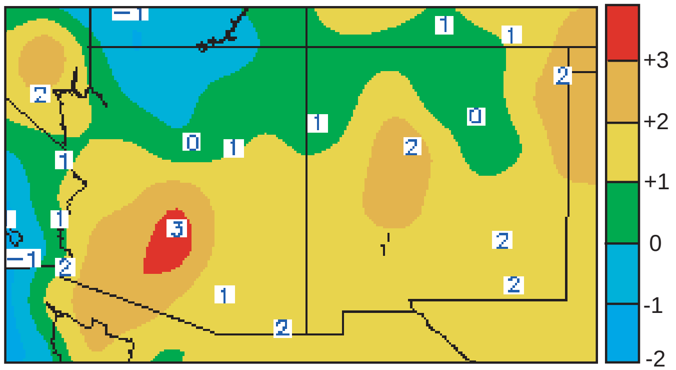
The climate products in this packet are available on the web:
http://www.ispe.arizona.edu/climas/forecasts/swoutlook.html

Section B

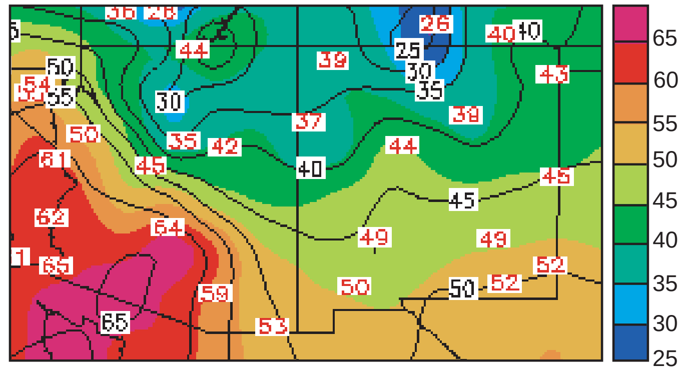
RECENT CONDITIONS

1. Recent Conditions: Temperature (up to 2/21/04) ♦ Sources: WRCC, HPRCC

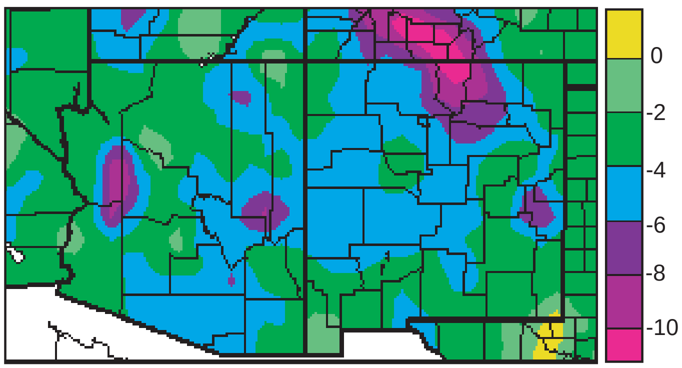
1a. Water year '03-'04 (through 2/21) departure from average temperature (°F).



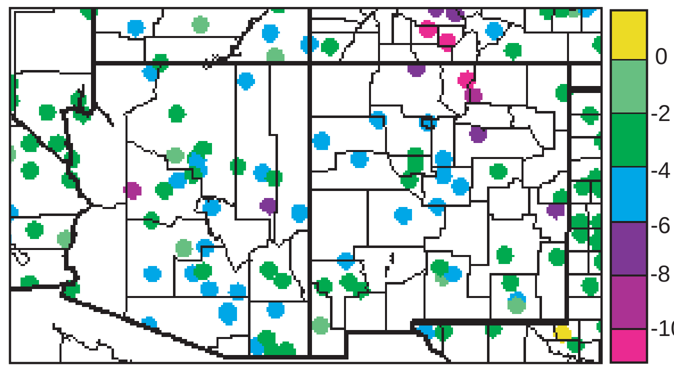
1b. Water year '03-'04 (through 2/21) average temperature (°F).



1c. Previous 30 days (1/24 - 2/22) departure from average temperature (°F, interpolated).



1d. Previous 30 days (1/24 - 2/22) departure from average temperature (°F, data collection locations only).



Highlights: Despite the fact that temperatures since October 1, 2003 have been mostly above average across our region (Figure 1a), temperatures during the past 30 days have been well below average (Figures 1c and 1d). Late January to mid-February temperatures were as much as 7-8°F below average at many locations across our region. The Tucson National Weather Service forecast office reported that, at many locations in southeastern Arizona, temperatures for the first half of February have not been this cold for more than 15 years. Some locations have not been this cold since 1964. According to reports from the Western Regional Climate Center (figures not shown), maximum temperatures at Southwest airport weather stations have been well below average during the past 30 days.

For these and other temperature maps, visit: http://www.wrcc.dri.edu/recent_climate.html and http://www.hprcc.unl.edu/products/current.html

For information on temperature and precipitation trends, visit: http://www.cpc.ncep.noaa.gov/trndtext.htm

Notes:

The water year begins on October 1 and ends on September 30 of the following year. Water year is more commonly used in association with precipitation; water year temperature can be used to measure the temperatures associated with the hydrological activity during the water year.

Average refers to the arithmetic mean of annual data from 1971–2000. Data are in degrees Fahrenheit (°F).

Departure from average temperature is calculated by subtracting current data from the average. The result can be positive or negative.

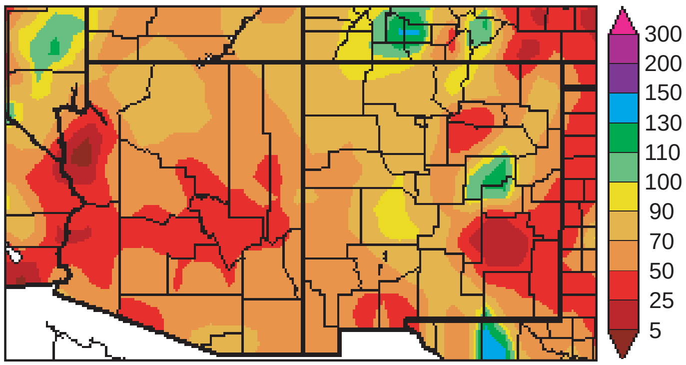
The continuous color maps (Figures 1a, 1b, 1c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. The blue numbers in Figure 1a, the red numbers in Figure 1b, and the dots in Figure 1d show data values for individual stations.

Note: Interpolation procedures can cause aberrant values in data-sparse regions.

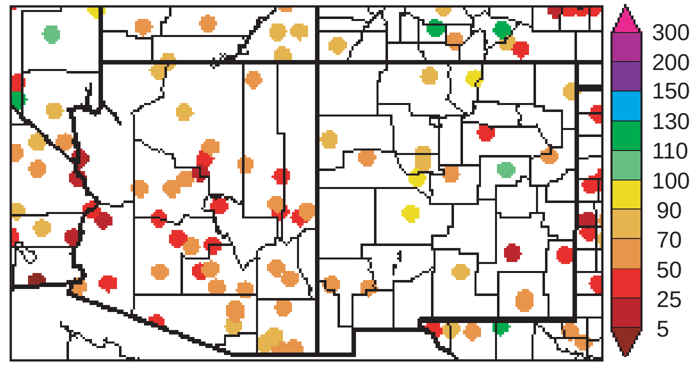
Figures 1c and 1d are experimental products from the High Plains Regional Climate Center (HPRCC).

2. Recent Conditions: Precipitation (up to 2/22/04) ♦ Source: High Plains Regional Climate Center

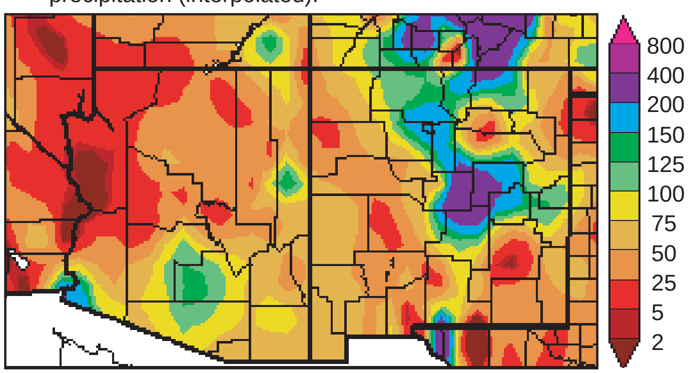
2a. Water year '03-'04 (through 2/22) percent of average precipitation (interpolated).



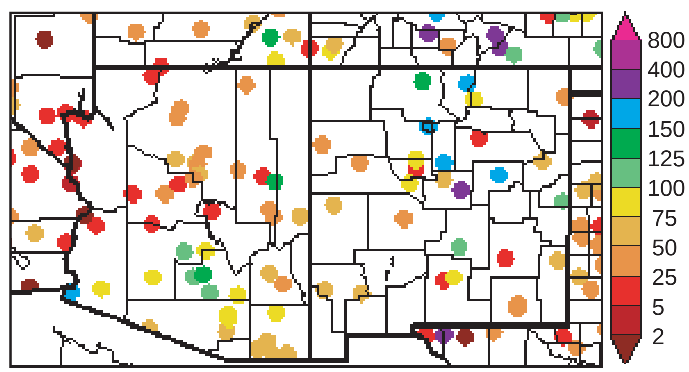
2b. Water year '03-'04 (through 2/22) percent of average precipitation (data collection locations only).



2c. Previous 30 days (1/24 - 2/22) percent of average precipitation (interpolated).



2d. Previous 30 days (1/24 - 2/22) percent of average precipitation (data collection locations only).



Highlights: During the past 30 days, our region has received scattered precipitation (heavy in places) from three events—one at the end of January (affecting mostly the Southern half of our region), one at the beginning of February, and one as this Southwest Climate Outlook goes to press. The highest precipitation totals were received in south-central Arizona and central New Mexico (Figures 2c and 2d). Precipitation from these events, however, did not put much of a dent in water year precipitation totals, which are still below average for most of our region (Figures 2a and 2b). Persistently dry conditions and high winds in southeastern New Mexico and west Texas generated severe dust storms that resulted in two deaths as 30 vehicles crashed on U.S. Highway 84, southeast of Lubbock, Texas (Associated Press, February 20, 2004).

For these and other precipitation maps, visit: http://www.hprcc.unl.edu/products/current.html
For National Climatic Data Center monthly precipitation and drought reports for Arizona, New Mexico, and the Southwest region, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/2003/perspectives.html#monthly

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2003 we are in the 2004 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year.

Average refers to the arithmetic mean of annual data from 1971–2000.

Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

The continuous color maps (Figures 2a, 2c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points.

Note: Interpolation procedures can cause aberrant values in data-sparse regions.

The dots in Figures 2b and 2d show data values for individual meteorological stations.

These figures are experimental products from the High Plains Regional Climate Center (HPRCC).

3. Annual Precipitation Anomalies and Daily Event Totals ♦ Source: NOAA Climate Prediction Center

Notes: Based on a long-term average (1971–2000) of daily precipitation, these graphs contrast how much precipitation actually has accumulated at each station over the past year (beginning in mid-December 2002) with how much precipitation typically is received.

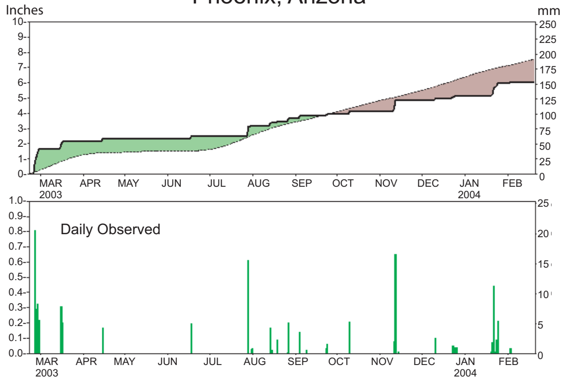
The top of each of the pairs of graphs shows average (dotted line) and actual (solid line) accumulated precipitation (i.e., each day's precipitation total is added to the previous day's total for a 365-day period). If accumulated precipitation is below the long-term average, the region between the long-term average and the actual precipitation is shaded brown, and if accumulated precipitation is above the long-term average, the region between the actual precipitation and the long-term average precipitation is shaded green.

The green bars at the bottom of each of the pairs of graphs show the daily precipitation amounts (in both inches and millimeters) for the past year. Thus, one can get a sense of how frequent and intense individual precipitation events have been at the selected stations.

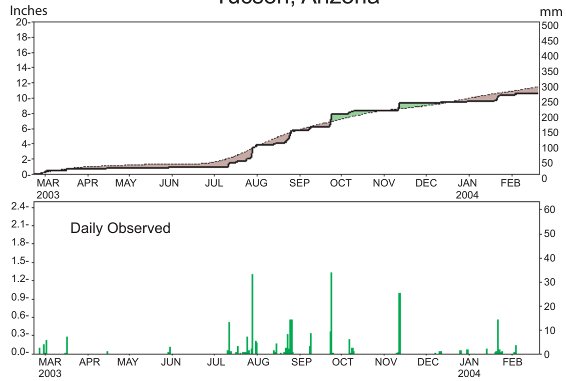
It is important to note that the scales for both the accumulated precipitation and the daily precipitation vary from station to station.

This type of graph is available for several other stations in Arizona and New Mexico as well as for many other places in the world. The graphs are updated daily by NOAA CPC at http://www.cpc.noaa.gov/products/global_monitoring/precipitation/global_precip_accum.html.

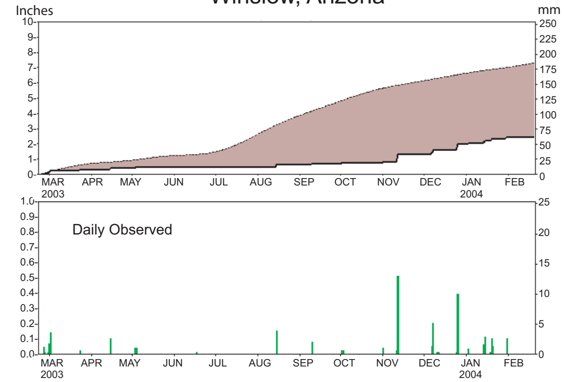
Phoenix, Arizona



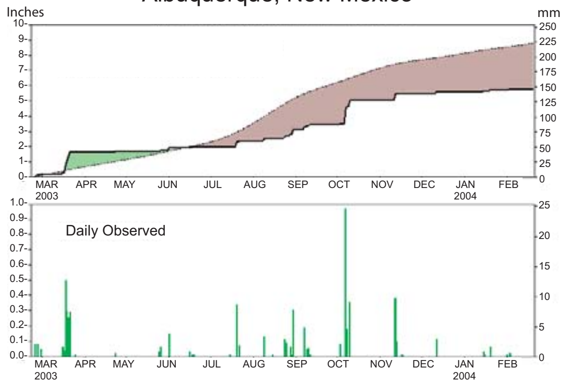
Tucson, Arizona



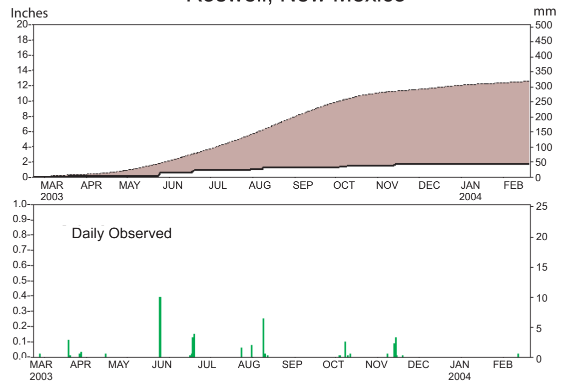
Winslow, Arizona



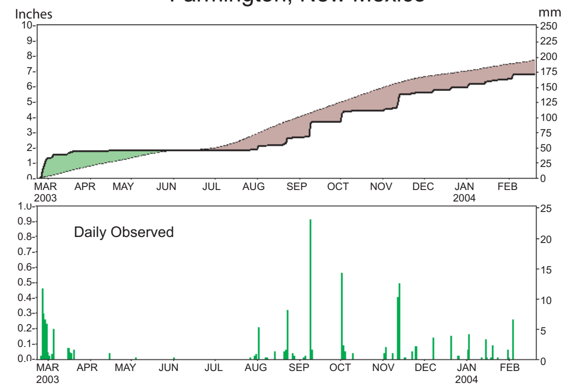
Albuquerque, New Mexico



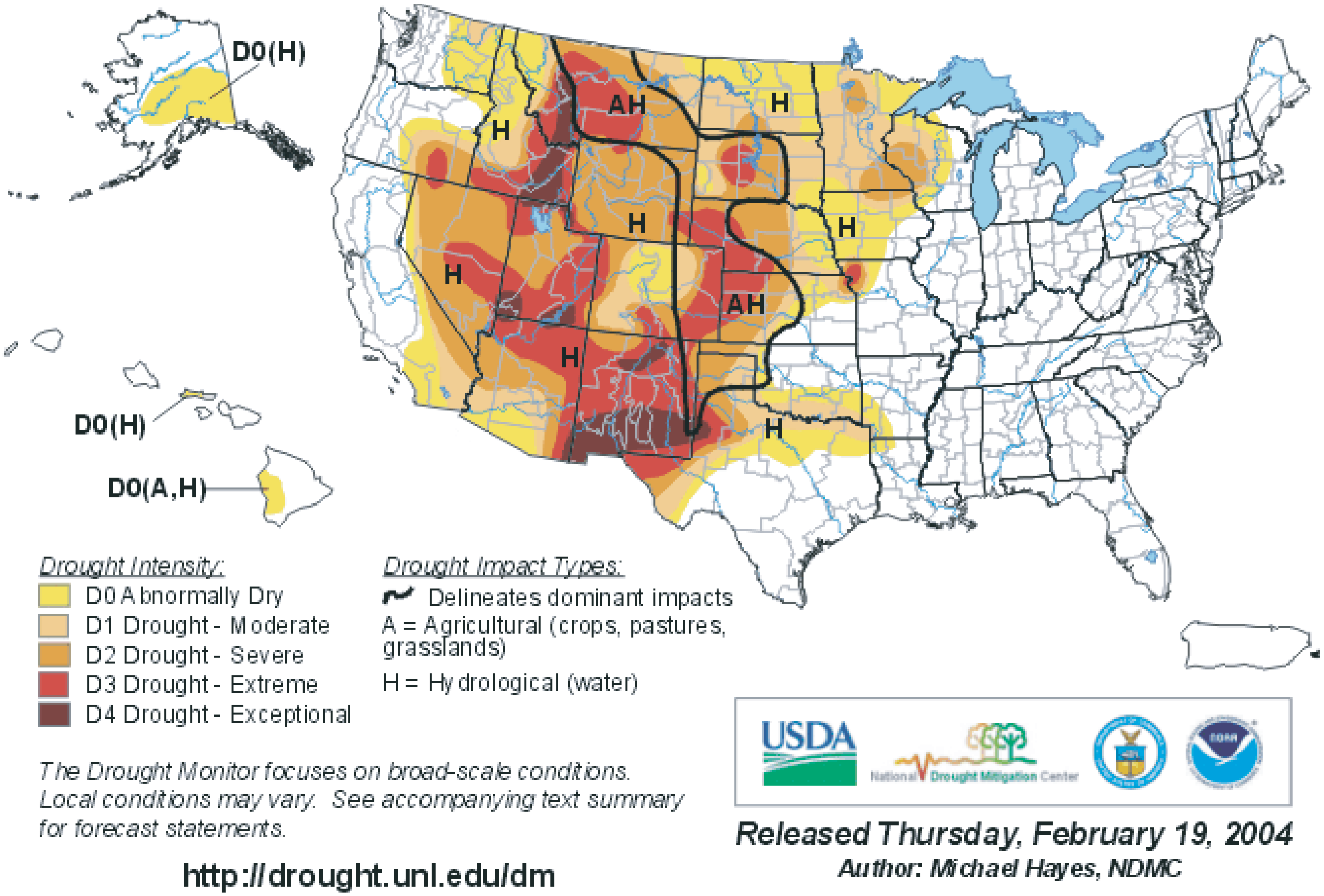
Roswell, New Mexico



Farmington, New Mexico



4. U.S. Drought Monitor (updated 2/19/04) ♦ Source: USDA, NDMC, NOAA



Notes:

The U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. This monitor was released on 2/19 and is based on data collected through 2/17.

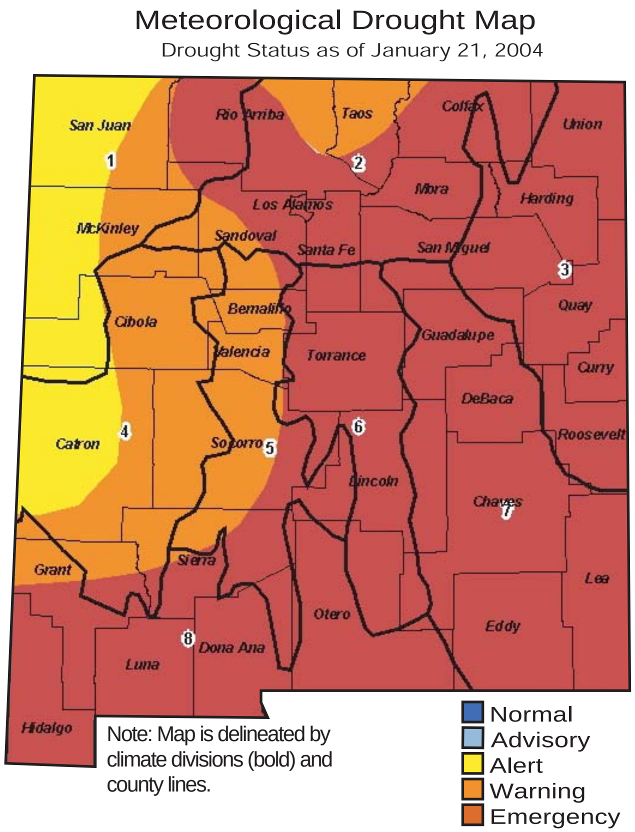
The best way to monitor drought trends is to pay a weekly visit to the U.S. Drought Monitor website (see left and below).

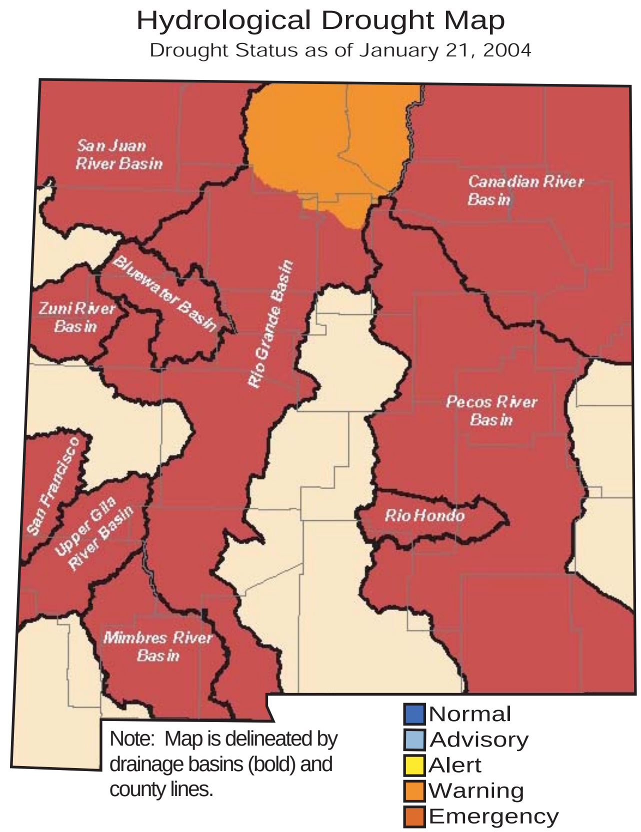
The U.S. Drought Monitor maps are based on expert assessment of variables including (but not limited to) PDSI, soil moisture, stream flow, precipitation, and measures of vegetation stress, as well as reports of drought impacts.

Highlights: Drought conditions persist across much of the Intermountain West and western Great Plains. In Arizona and New Mexico, hydrological drought conditions are still evident in the four corners area and across the southern tier of our region stretching from southeastern Arizona to west Texas. Drought conditions in southern New Mexico and west Texas have been exceedingly severe; high winds and dry conditions resulted in severe dust storm events on February 19, 2004. United States Secretary of the Interior Gale Norton visited Arizona and told members of a Phoenix Rotary Club that the current drought is "a warning call for the future" (*Arizona Republic*, February 7, 2004). Norton suggested that more efficient agricultural use of water would free up water for the West's growing urban areas.

Animations of the current and past weekly drought monitor maps can be viewed at: http://www.drought.unl.edu/dm/monitor.html

5. Drought: Recent Drought Status for New Mexico (updated 01/21/04) Source: New Mexico NRCS

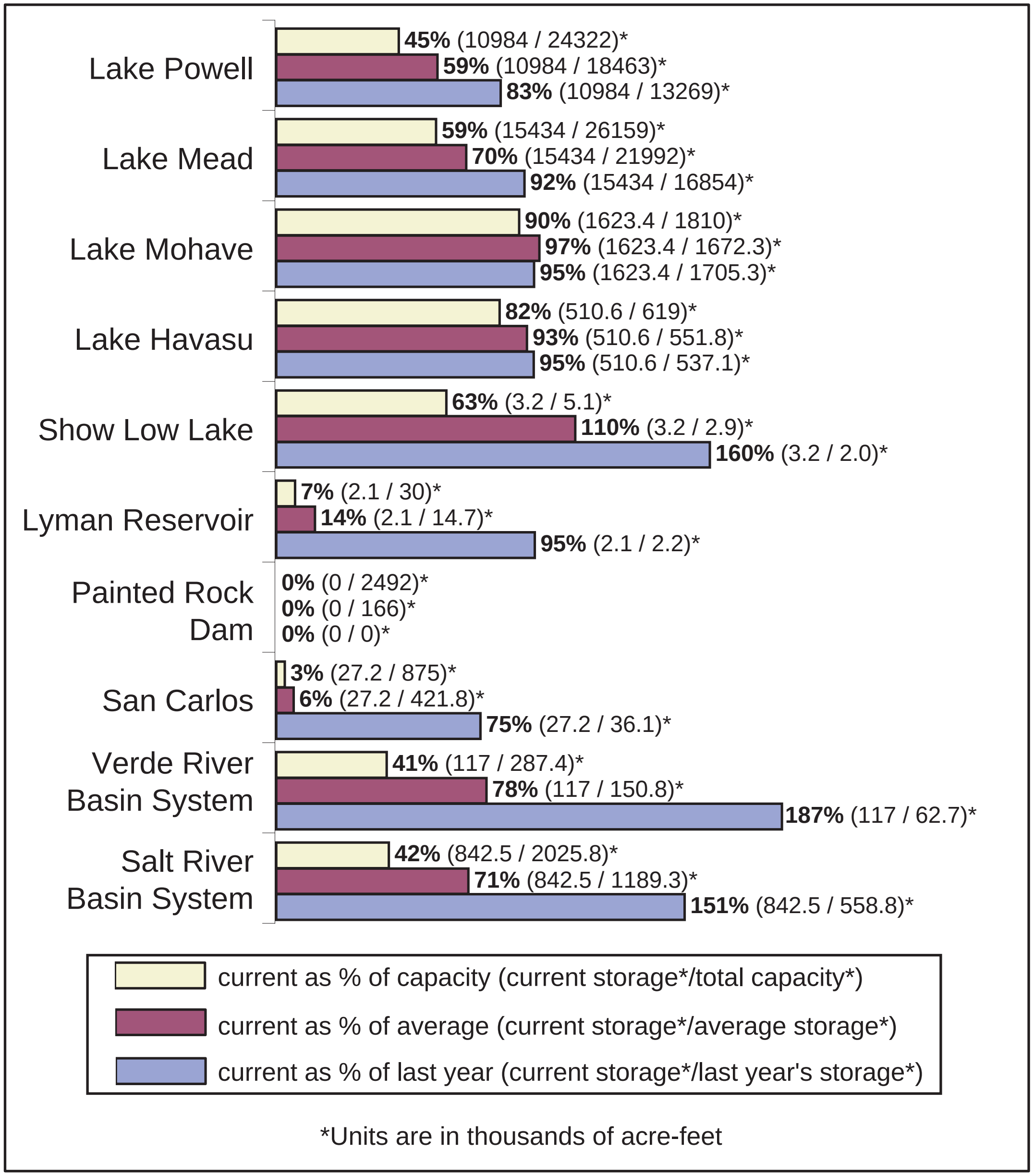




Notes: New Mexico drought status maps are produced by the New Mexico Drought Monitoring Workgroup (NMDMW). As with the U.S. Drought Monitor maps (see page 4), the New Mexico maps are based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow. The New Mexico drought status maps (http://www.nm.nrcs.usda.gov/snow/drought/drought.html) are produced monthly. When near-normal conditions exist, they are updated quarterly. Information on Arizona drought can be found at: http://www.water.az.gov/gdtf/

Highlights: Changes in New Mexico meteorological drought status since November 2003, include the following: increases to emergency drought status in Socorro and Sierra counties; a decrease from emergency to warning status in north-central New Mexico; a decrease from warning to alert status in west central New Mexico. Hydrological drought has increased to emergency drought status in the northwest Pecos River Basin, since November 2003. The National Weather Service Albuquerque forecast office reports that soils are still suffering from multi-year drought over much of New Mexico. Despite average to above-average snowfall over parts of northwestern and north-central New Mexico, runoff into many New Mexico streams may be below average because, as in 2003, extremely dry soils can absorb a substantial volume of water.

6. Arizona Reservoir Levels (through the end of January 2004) Source: USDA NRCS



Notes: Reservoir reports are updated monthly and are provided by the National Water and Climate Center (NWCC) of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). Portions of the information provided in this figure can be accessed at the NRCS website: http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html

As of 2/16/04, Arizona's report had been updated through the end of January.

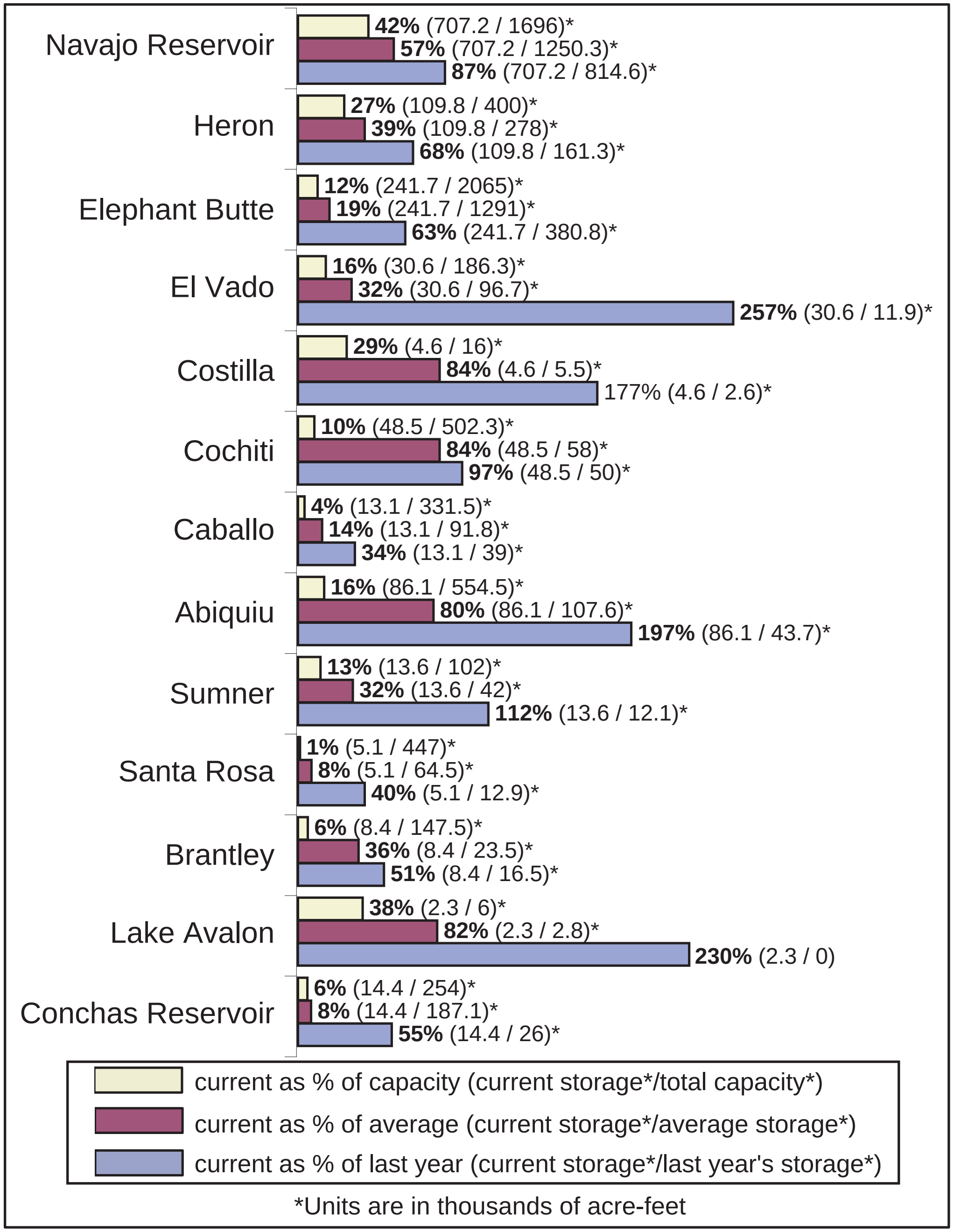
For additional information, contact Tom Pagano of the NWCC-NRCS-USDA (tpagano@wcc.nrcs.usda.gov; 503-414-3010) or Larry Martinez, NRCS, USDA, 3003 N. Central Ave, Suite 800, Phoenix, Arizona 85012-2945; 602-280-8841; Larry.Martinez@az.usda.gov)

Highlights: There have been slight gains in some Arizona reservoirs during the past month. In particular, the Salt and Verde River Basins have seen slight increases in current storage and percent of total capacity. Total Colorado River reservoir current storage levels continue to decline.

The *Arizona Republic* (February 1, 2004) reported that the Williams City Council approved a preliminary master plan for a $32 million Arizona Territory theme park. Investors in the project will probably need to drill their own well or haul water, as the city's surface water ponds have dried significantly due to drought.

According to a February 6, 2004 *Arizona Republic* report, the Central Arizona Project (CAP) could continue to fill orders if our multi-year drought persists into the next decade. CAP investigated prolonged drought scenarios and determined that, by shifting water from agricultural to municipal/industrial and tribal use, CAP could provide supplies to homes and businesses in an even more prolonged drought.

7. New Mexico Reservoir Levels (through the end of January 2004) Source: USDA NRCS



Notes: Reservoir reports are updated monthly and are provided by the National Water and Climate Center (NWCC) of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). Reports can be accessed at their website:
http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html.

As of 2/16/04, New Mexico's report had been updated through the end of January.

For additional information, contact Tom Pagano of the NWCC-NRCS-USDA (tpagano@wcc.nrcs.usda.gov; 503-414-3010) or Dan Murray, NRCS, USDA, 6200 Jefferson NE, Albuquerque, NM 87109; 505-761-4436; Dan.Murray@nm.usda.gov)

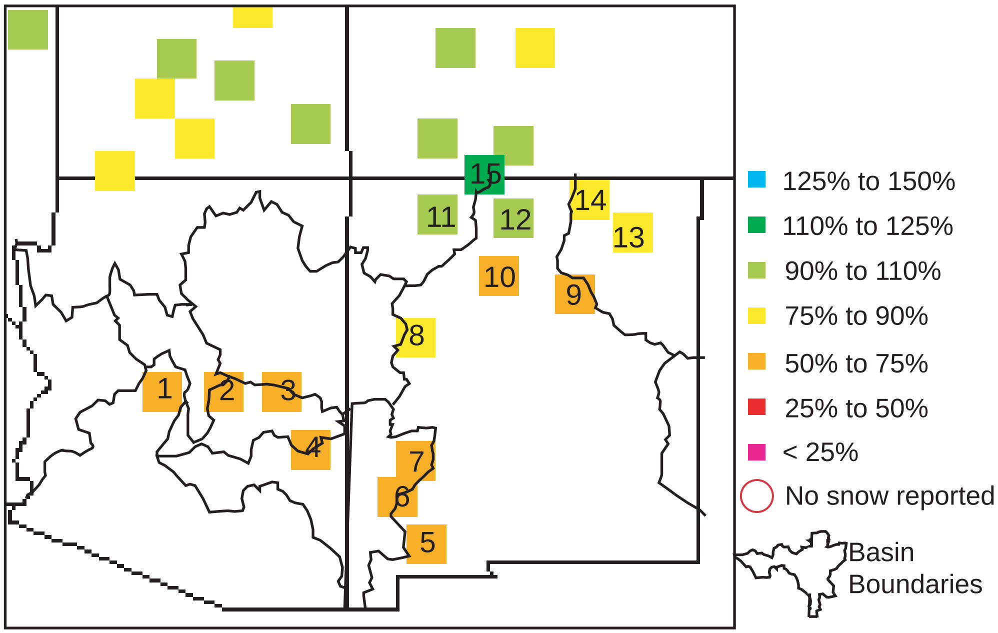
Highlights: Many New Mexico reservoirs registered slight gains since January 2004. Total reservoir storage for the state increased one percentage point (about 40,000 acre-feet) from what it was in January, according to a USDA-NRCS report. An acre-foot is the amount of water required to fill one acre to the level of one foot, and is approximately enough water to provide for the water needs of several families for one year. Overall reservoir levels continue to be well below average across the state.

Recent precipitation could result in increases, but dry soils might absorb significant volumes of moisture. "It's much like having that snowpack sitting on a dry sponge," said Richard Armijo, a snow surveyor for USDA-NRCS in Albuquerque (*El Paso Times*, February 12, 2004). According to a February 20, 2004 report in the *Albuquerque Journal*, recent snow has provided Santa Fe city reservoirs with more water than they have recorded in mid-February during the past two years.

An *El Paso Times* report (February 12, 2004) suggests that water allocations for the Elephant Butte Irrigation District will again be down from average allocations. Officials say that farmers are planning for shortage by planting fewer crops and supplementing surface water supplies with groundwater.

8. Snowpack in the Southwestern United States (updated 2/23/04) ♦ Source: USDA NRCS, WRCC

8. Basin average snow water content (SWC) for available monitoring sites as of 2/23/04 (% of average).



Arizona Basins

1 Verde River Basin
2 Central Mogollon Rim
3 Little Colorado - Southern Headwaters
4 Salt River Basin

New Mexico Basins

5 Mimbres River Basin
6 San Francisco River Basin
7 Gila River Basin
8 Zuni/Bluewater River Basin
9 Pecos River
10 Jemez River Basin
11 San Miguel, Dolores, Animas, and San Juan River Basins
12 Rio Chama River Basin
13 Cimarron River Basin
14 Sangre de Cristo Mountain Range Basin
15 San Juan River Headwaters

Highlights: Snowpack remains below-average throughout Arizona and New Mexico. Snow water content (SWC) across Arizona and southwestern New Mexico is between 59–77 percent of average as this Southwest Climate Outlook goes to press. Above-average SWC has been received in the headwaters of the Rio Grande River Basin. However, soils depleted by multi-year drought might deprive the Rio Grande of the benefits of these increases. Below-average snowfall since the mid-1990s has financially hurt the 777-acre Arizona Snowbowl ski area in the San Francisco Peaks, north of Flagstaff, Arizona (*Tucson Citizen*, February 16, 2004). There has been some controversy over USDA-Forest Service officials support snowmaking plans at the Arizona Snowbowl, in order to maintain ski operations during low-snow (drought) years. The snowmaking plan requires Flagstaff to sell reclaimed water to the Snowbowl.

For color maps of SNOTEL basin SWC, visit: http://www.wrcc.dri.edu/snotelanom/basinswe.html
For a numeric version of the SWC map, visit: http://www.wrcc.dri.edu/snotelanom/basinswen.html
For a list of river basin SWC and precipitation, visit http://www.wrcc.dri.edu/snotelanom/snotelbasin

Notes:

The data shown on this page are from snowpack telemetry (SNOTEL) stations grouped according to river basin. These remote stations sample snow, temperature, precipitation, and other parameters at individual sites.

Snow water content (SWC) and snow water equivalent (SWE) are different terms for the *same* parameter.

The SWC in Figure 8 refers to the snow water content found at selected SNOTEL sites in or near each basin compared to the *average* value for those sites on this day. *Average* refers to the arithmetic mean of annual data from 1971-2000. SWC is the amount of water currently in snow. It depends on the density and consistency of the snow. Wet, heavy snow will produce greater SWC than light, powdery snow.

Each box on the map represents a river basin for which SWC data from individual SNOTEL sites have been averaged. Arizona and New Mexico river basins for which SNOTEL SWC estimates are available are numbered in Figure 8. The colors of the boxes correspond to the percent of average SWC in the river basins.

The dark lines within state boundaries delineate large river basins in the Southwest.

These data are provisional and subject to revision. They have not been processed for quality assurance. However, they provide the best available land-based estimates during the snow measurement season.

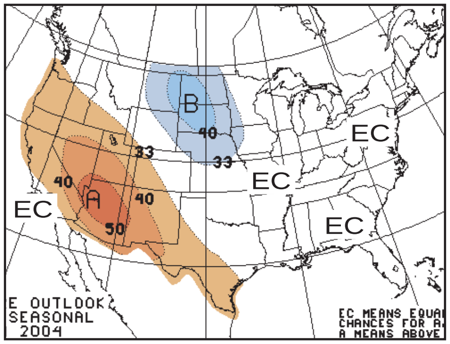
Section C

FORECASTS

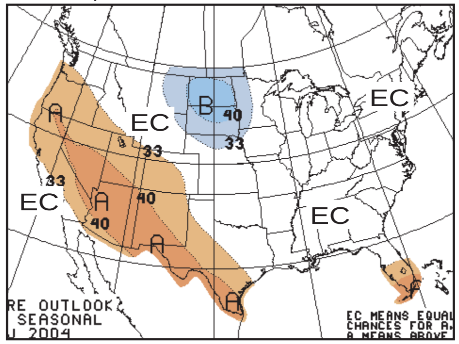
9. Temperature: Multi-season Outlooks ♦ Source: NOAA Climate Prediction Center

Overlapping 3-month long-lead temperature forecasts (released 2/19/04).

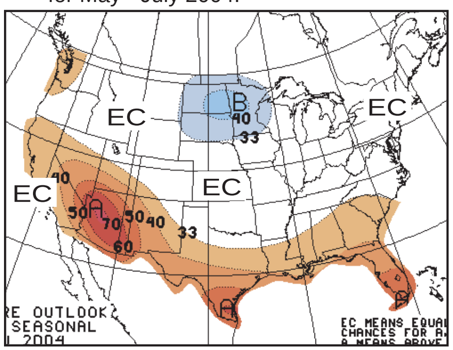
9a. Long-lead national temperature forecast for March - May 2004.



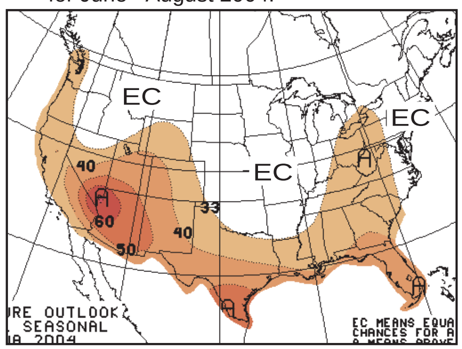
9b. Long-lead national temperature forecast for April - June 2004.



9c. Long-lead national temperature forecast for May - July 2004.



9d. Long-lead national temperature forecast for June - August 2004.



Percent Likelihood of Above and Below Average Temperatures*

- > 70%
- 60% - 69.9%
- 50% - 59.9% A = Above
- 40% - 49.9%
- 33% - 39.9%

- 33% - 39.9% B = Below
- 40% - 49.9%

*EC indicates no forecasted anomalies due to lack of model skill.

Highlights: The NOAA-CPC temperature outlooks for March through August 2004 continue to show considerably increased probabilities of above-average temperatures for many areas of the Southwest. Although the maximum likelihood of above-average temperatures through June is somewhat decreased compared to the previous month's outlook, temperature projections for July and August suggest maximum likelihoods of above-average temperatures of greater than 60 to 70 percent over much of Arizona. The CPC predictions are based primarily on agreement between long-term temperature trends for the region and statistical models. The predictions indicate very good agreement among dynamical models regarding an atmospheric circulation pattern that favors high temperatures over the western United States. The International Research Institute for Climate Prediction temperature forecasts (not pictured) also indicate increased probabilities of above-average temperature for the southwestern United States through at least June 2004.

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
Please note that this website has many graphics and may load slowly on your computer.
For IRI forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/

Notes:

The NOAA CPC (National Oceanic and Atmospheric Administration Climate Prediction Center) outlooks predict the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature.

In a situation where there is no forecast skill, one might look at average conditions in order to get an idea of what might happen. Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average temperature.

Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3-40.0 percent chance of above-average, a 33.3 percent chance of average, and a 26.7-33.3 percent chance of below-average temperature.

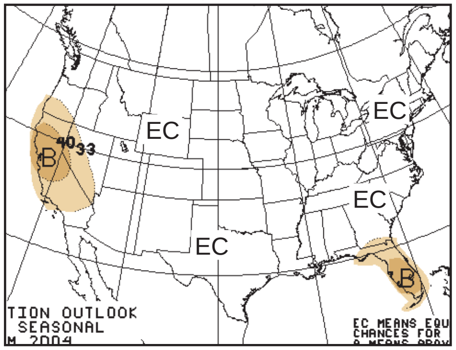
The term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

Equal Chances (EC) indicates areas where reliability (i.e., the 'skill') of the forecast is poor and no anomaly prediction is offered.

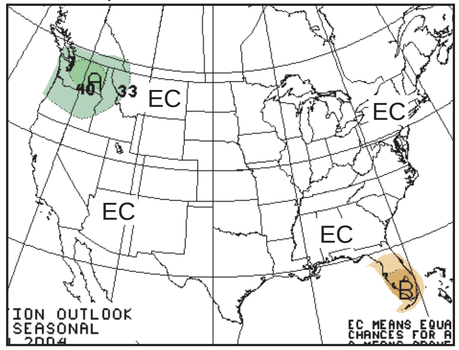
10. Precipitation: Multi-season Outlooks ♦ Source: NOAA Climate Prediction Center

Overlapping 3-month long-lead precipitation forcasts (released 2/19/04).

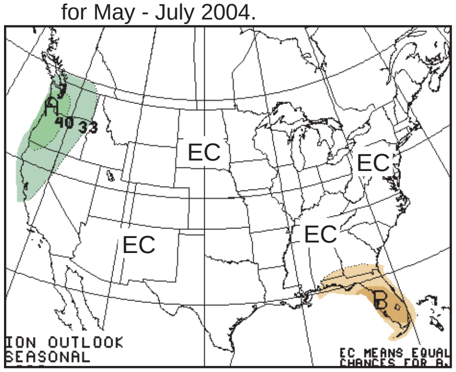
10a. Long-lead U.S. precipitation forecast for March - May 2004.



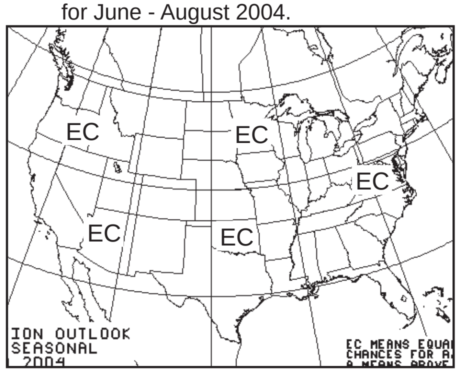
10b. Long-lead U.S. precipitation forecast for April - June 2004.



10c. Long-lead U.S. precipitation forecast for May - July 2004.



10d. Long-lead U.S. precipitation forecast for June - August 2004.



Percent Likelihood of Above or Below Average Precipitation*

> 40% / 33% - 40% — A = Above

33% - 40% / > 40% — B = Below

*EC indicates no forecasted anomalies due to lack of model skill.

Highlights: The NOAA-CPC forecast for March 2004 (not pictured) indicates slightly increased probabilities of above-average precipitation in southeastern Arizona and southwestern New Mexico. However, the longer outlook through August 2004 does not suggest strong probability anomalies for either above- or below-normal precipitation. Confidence in this forecast is derived primarily from agreement among statistical models. The International Research Institute for Climate Prediction precipitation forecasts through August 2004 (not pictured) deviate somewhat from the CPC outlooks by indicating slightly increased probabilities (40%) of below-average precipitation for the southern tier of Arizona and New Mexico during May-July.

For more information, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
Please note that this website has many graphics and may load slowly on your computer.
For more information about IRI experimental forecasts, visit: http://iri.columbia.edu/climate/forecast/net_asmt/

Notes:

The NOAA CPC (National Oceanic and Atmospheric Administration Climate Prediction Center) outlooks predict the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation.

In a situation where there is no forecast skill, one might look at *average* conditions in order to get an idea of what might happen. Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average precipitation.

Thus, using the NOAA CPC likelihood forecast, in areas with light green shading there is a 33.3-40.0 percent chance of above-average, a 33.3 percent chance of average, and a 26.7-33.3 percent chance of below-average precipitation.

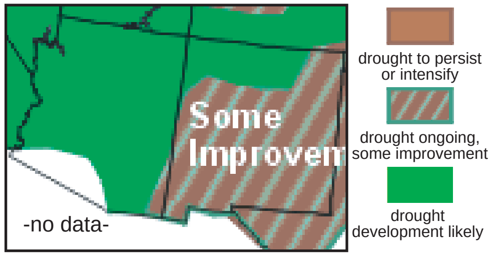
The term *average* refers to the 1971–2000 average. This practice is standard in the field of climatology.

Equal Chances (EC) indicates areas where reliability (i.e., the 'skill') of the forecast is poor and no anomaly prediction is offered.

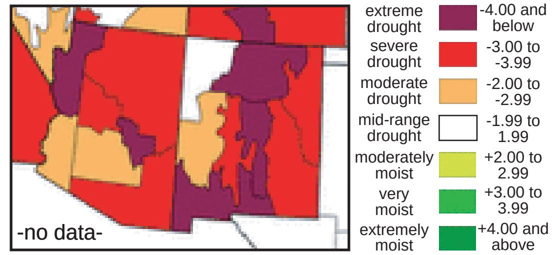
11. Drought: Seasonal Drought and PHDI Outlook Maps ♦ Sources: NOAA-CPC, NCDC

Notes:
The delineated areas in the Seasonal Drought Outlook (Fig. 11a) are defined subjectively and are based on expert assessment of numerous indicators, including outputs of short- and long-term forecasting models.

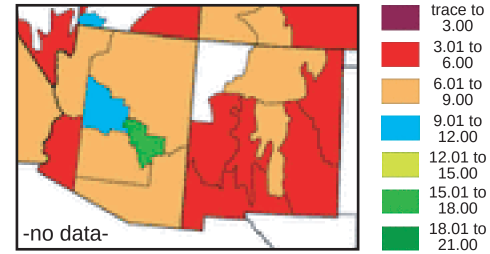
11a. Seasonal drought outlook through May 2004 (accessed 2/19).



11b. January 2004 PHDI conditions (accessed 2/19).

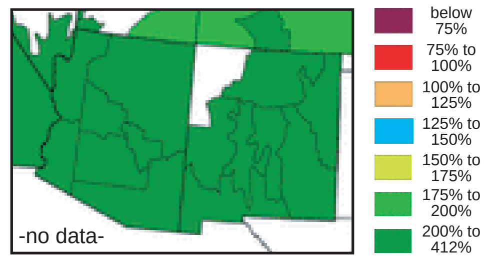


11c. Precipitation (in.) required to end current drought conditions in three months.



Figures 11b-e are based on the Palmer Hydrological Drought Index (PHDI), which reflects long-term precipitation deficits. PHDI is a measure of reservoir and groundwater level impacts, which take a relatively long time to develop and to recover from drought. Figure 11b shows the current PHDI status for Arizona and New Mexico.

11d. Percent of average precipitation required to end current drought conditions in three months.



11e. Probability of receiving precipitation required to end current drought conditions in three months.

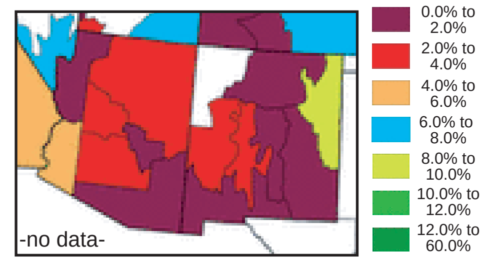


Figure 11c shows the amount of precipitation, in inches, needed over the next three months to change a region's PHDI status to -0.5 or greater—in other words, to end the drought. Regions shown in white have a current PHDI value greater than –2.0 (e.g., in Figure 11b - e, these regions are not in hydrological drought).

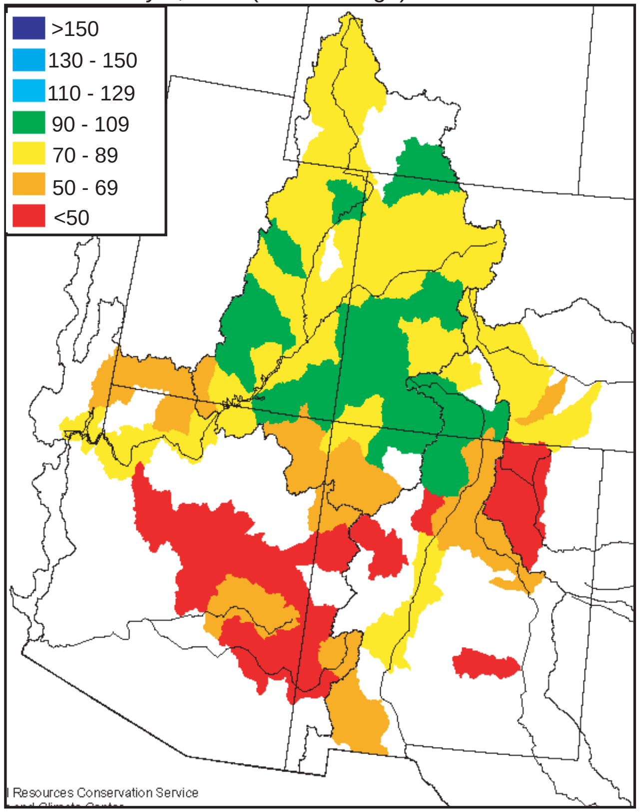
The season in which the precipitation falls greatly influences the amount of precipitation needed to end a drought. For example, during a typically wet season more precipitation may be required to end a drought than during a typically dry season. Also, because soil moisture conditions generally are lower in the dry seasons, the precipitation needed to bring soil conditions back to normal may be less than that required to return soil moisture conditions to normal during a generally wetter season. Figure 11d shows the percent of average precipitation needed to end drought conditions in three months, based on regional precipitation records from 1961–1990. A region that typically experiences extreme precipitation events during the summer, for example, may be more likely to receive enough rain to end a drought than a region that typically is dry during the same season. The seasons with the greatest probability of receiving substantially more precipitation than average are those subject to more extreme precipitation events (such as hurricane-related rainfall), not necessarily those seasons that normally receive the greatest average amounts of precipitation. Figure 11e shows the probability, based on historical precipitation patterns, of regions in Arizona and New Mexico receiving enough precipitation in the next three months to end the drought. Note that these probabilities do not take into account atmospheric and climatic variability (such as El Niño-Southern Oscillation), which also influence seasonal precipitation probabilities.

Highlights: The U.S. Seasonal Drought Outlook (Figure 11a) indicates that improvement in drought conditions is likely for Arizona and northern New Mexico through May 2004. However, the probability of ending drought within the next three months, based on analysis of historical data, is still exceedingly low for most of the Southwest.

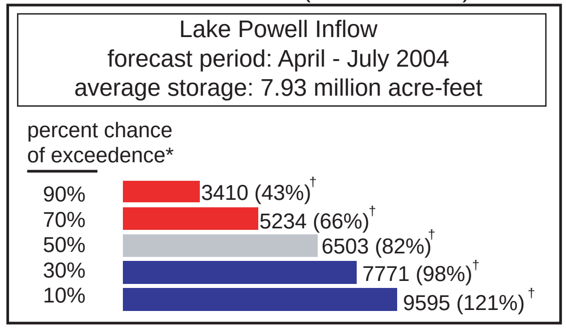
For more information, visit: http://www.drought.noaa.gov/ —and— http://www.ncdc.noaa.gov/oa/climate/research/drought/drought.html

12. Streamflow Forecast for Spring and Summer ♦ Source: USDA NRCS National Water and Climate Center

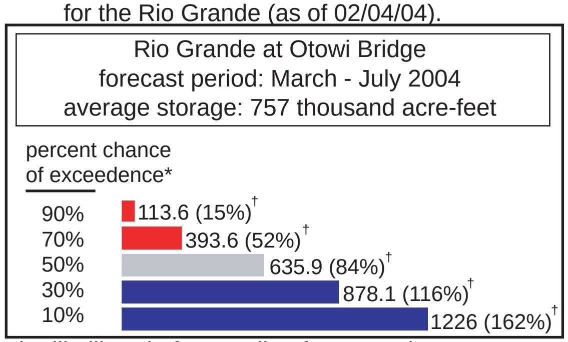
12a. NRCS spring and summer streamflow forecast as of February 1, 2004 (% of average).



12b. NRCS percent exceedence forecast chart for Lake Powell inflow (as of 02/04/04).



12c. NRCS percent exceedence forecast chart for the Rio Grande (as of 02/04/04).



*the likelihood of exceeding forecasted streamflow volume.

†associated forecasted streamflow volume (thousands of acre-feet) and percent of average volume.

Highlights: Below-average streamflow is most likely this spring and summer for most of Arizona and New Mexico river basins. The San Juan and Upper Rio Grande are the only river basins in the two states that are predicted to have streamflows near or slightly-above average. The most probable inflow to Lake Powell is predicted to be 82 percent of the 1971–2000 average (Figure 12b), with only a 30 percent chance of near-average (98 percent) inflow. The most probable inflow to the Rio Grande at Otowi Bridge is predicted to be 84 percent of average. New Mexico has entered into purchase agreements with landowners in the Pecos River Basin, in order to secure land and water rights so the state can ensure water deliveries to Texas (Associated Press, February 18, 2004). However, State Engineer John D'Antonio is concerned that a lack of funds could delay plans. Texas senator Kay Bailey Hutchinson called on the government of Mexico to repay a more than one million acre-feet of water debt to the United States (*Houston Chronicle*, February 17, 2004). Northern Mexico, which, like the Southwest has experienced multi-year drought, began falling behind on its water payments to the United States about a decade ago.

For state river basin streamflow probability charts, visit: http://www.wcc.nrcs.usda.gov/water/strm_cht.pl

For information on interpreting streamflow forecasts, visit: http://www.wcc.nrcs.usda.gov/factpub/intrpret.html

For western U.S. water supply outlooks, visit http://www.wcc.nrcs.usda.gov/water/quantity/westwide.html

Notes:

The forecast information provided in Figures 12a-c is updated monthly and is provided by the National Resources Conservation Service (NRCS). Unless otherwise specified, all streamflow forecasts are for streamflow volumes that would occur naturally without any upstream influences, such as reservoirs and diversions.

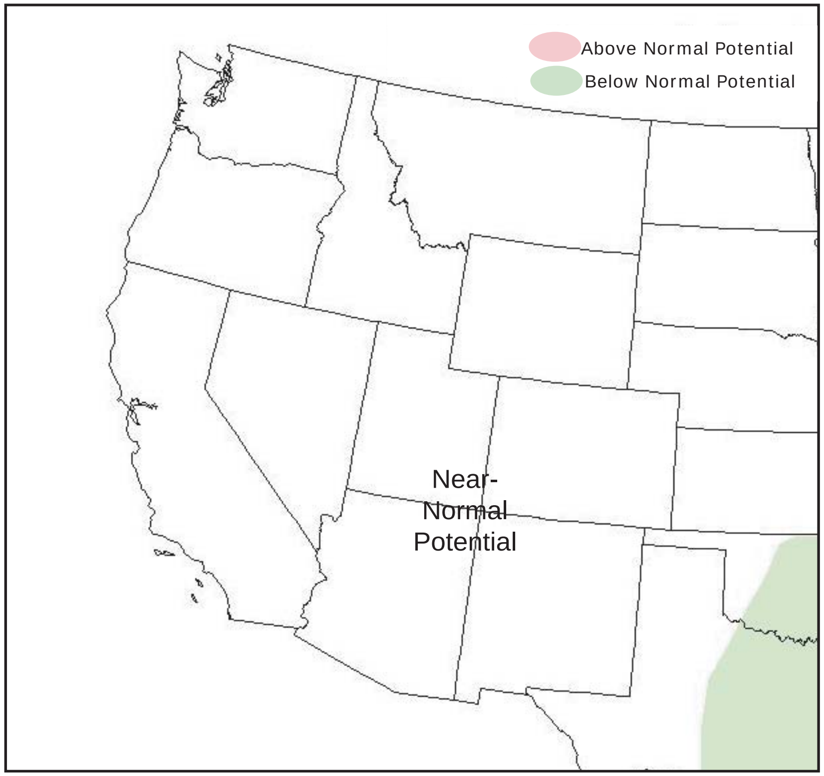
Each month, five streamflow volume forecasts are made by the NRCS for several river basins in the United States. These five forecasts correspond to standard *exceedence* percentages, which can be used as approximations for varying 'risk' thresholds when planning for short-term future water availability.

NRCS provides the 90, 70, 50, 30, and 10 percent exceedence streamflow volumes. Each exceedence percentage level corresponds to the following statement: "There is an (X) percent chance that the streamflow volume will exceed the forecast volume value for that exceedence percentage." Conversely, the forecast also implies that there is a (100-X) percent chance the volume will be less than this forecasted volume. In Figure 12c for example, there is a 30 percent chance that Rio Grande at Otowi Bridge will exceed 878.1 acre-feet of water (116 percent of average) between March and July and a 70 percent chance that it will not exceed that volume. Note that for an individual location, as the exceedence percentage declines, forecasted streamflow volume increases.

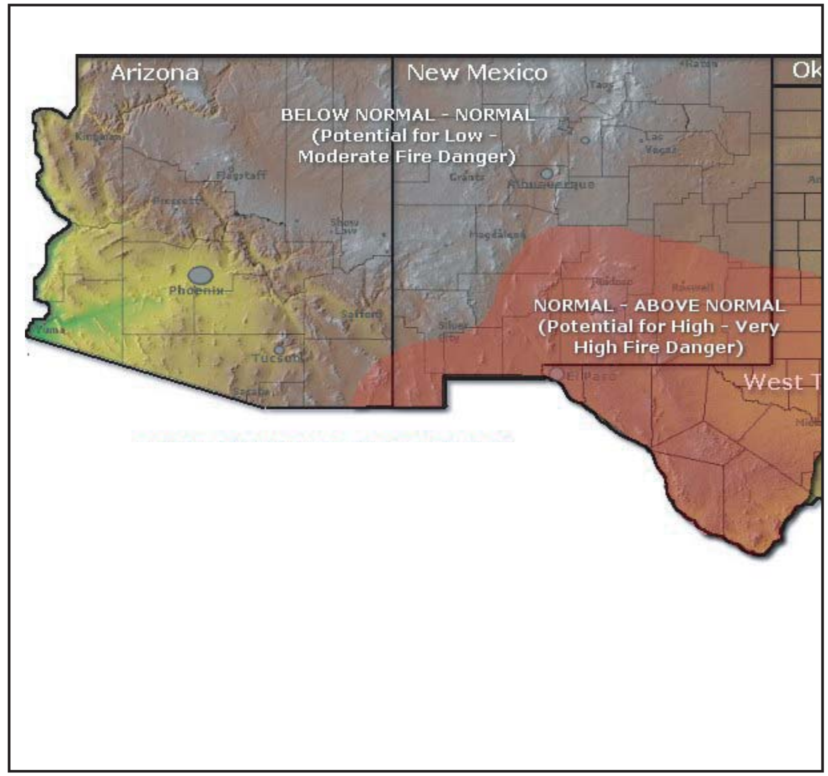
In addition to monthly graphical forecasts for individual points along rivers (Figures 12b and 12c), the NRCS provides a forecast map (Figure 12a) of basin-wide streamflow volume averages based on the forecasted 50 percent exceedence threshold.

13. National Wildland Fire Outlook Source: National Interagency Coordination Center

13a. Monthly wildfire outlook (valid February 1 - 29).



13b. Monthly fire danger outlook (valid February 1 - 29).

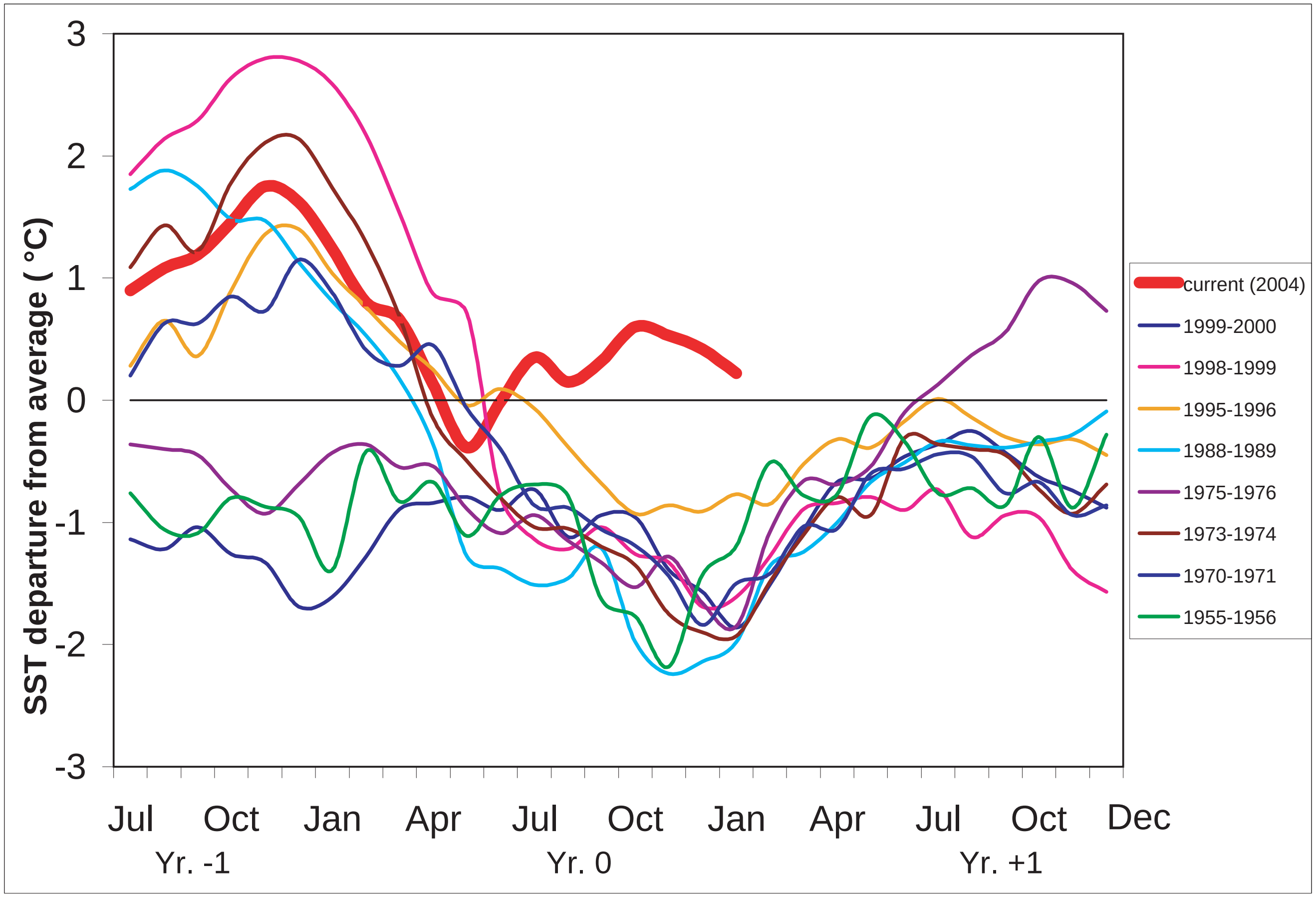


Notes: The National Interagency Coordination Center (NICC) at the National Interagency Fire Center (NIFC) produces monthly (Figure 13a) wildland fire outlooks. These forecasts consider climate forecasts and surface-fuels conditions in order to assess fire potential. They are subjective assessments, based on synthesis of regional fire danger outlooks. The Southwest Coordination Center (SWCC) produces more detailed monthly subjective assessments for Arizona, New Mexico, and west Texas (Figure 13b).

Highlights: The February 1-29, 2004 SWCC outlook is for normal to above-normal fire danger across southern New Mexico and west Texas (Figure 13b). The NICC forecast (Figure 13a) indicates below near-normal fire potential for our region, based on the potential for fires greater than 100 acres. Other indicators, such as observations of large fuel moisture readings (1000-hour fuels), and experimental measures of vegetation health and greenness for the Southwest (not pictured) indicate relatively low potential for large fires across northern Arizona and New Mexico. However, fine fuels, such as grass, are reported by the SWCC to be in a cured condition as of late January 2004.
For more detailed discussions, visit the National Wildland Fire Outlook web page: http://www.nifc.gov/news/nicc.html
and the Southwest Area Wildland Fire Operations (SWCC) web page: http://www.fs.fed.us/r3/fire/
For an array of climate and fire assessment tools, visit the Desert Research Institute program for Climate, Ecosystem, and Fire Applications (CEFA) web page: http://cefa.dri.edu/Assessment_Products/assess_index.htm

14. Tropical Pacific Sea Surface Temperature Forecast ♦ Sources: NOAA-CPC, IRI

14. Current (red) and past La Niña event sea surface temperature anomalies (°C) for the El Niño 3.4 monitoring region of the equatorial Pacific Ocean.



Notes: The graph (Figure 14) shows sea-surface temperature (SST) departures from the long-term average for the Niño 3.4 region in the central-eastern equatorial Pacific Ocean. SSTs in this region are a sensitive indicator of ENSO conditions.

Each line on the graph represents SST departures for previous La Niña events, beginning with the year before the event began (Yr. –1), continuing through the event year (Yr. 0), and into the decay of the event during the subsequent year (Yr. +1).

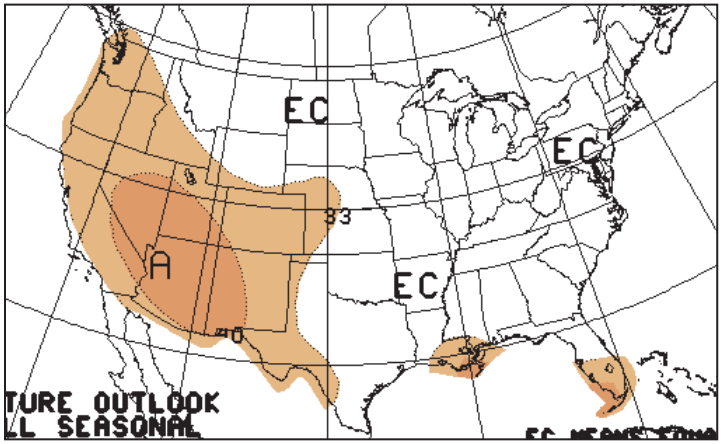
The most recent SST departures are plotted as a thick red line. The magnitude of the SST departure, its timing during the seasonal cycle, and its exact location in the equatorial Pacific Ocean are some of the factors that determine the degree of impacts experienced in the Southwest.

Highlights: Sea-surface temperatures (SSTs) remained slightly above average for most of the equatorial Pacific Ocean. The above-average SSTs experienced since early summer were not warm enough to constitute an official El Niño event. The International Research Institute for Climate Prediction states that the chance that an El Niño episode will develop between May and mid-summer is less than 50 percent. The chances of a La Niña episode developing during the same period are much less than that of an average year. Both IRI and NOAA's Climate Prediction Center agree that atmospheric conditions in the Pacific do not show trends that would support the development of an El Niño episode.

For a technical discussion of current El Niño conditions, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/
For more information about El Niño and to access graphics similar to the figure above, visit: http://iri.columbia.edu/climate/ENSO/

15. Temperature Verification: November 2003–January 2004 ♦ Source: NOAA Climate Prediction Center

15a. Long-lead U.S. temperature forecast for November 2003 - January 2004.

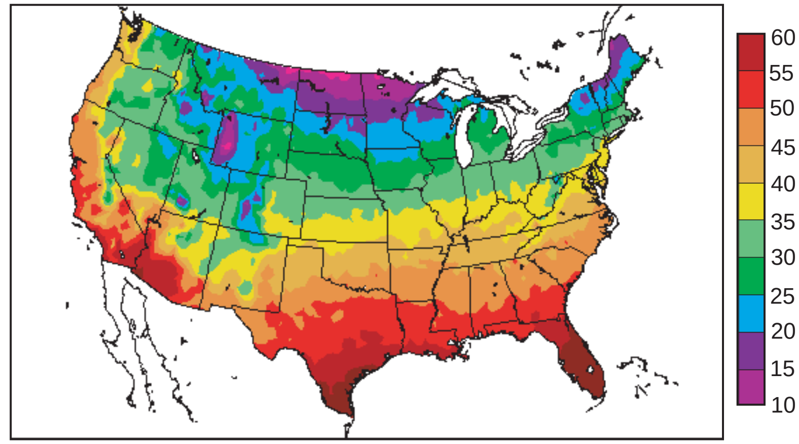


Percent Likelihood of Above and Below Average Temperatures*

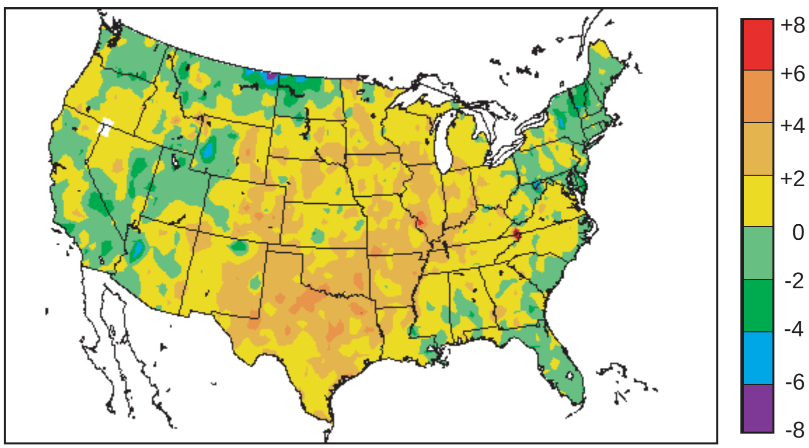
40% - 49% A = Above
33% - 39%

*EC indicates no forecasted anomalies due to lack of model skill.

15b. Average temperature (in °F) for November 2003 - January 2004.



15c. Average temperature departure (in °F) for November 2003 - January 2004.



Highlights: The NOAA-CPC November–January temperature outlook forecasted increased probabilities for above-average temperatures for all of the southwestern United States (Fig 15a). Most of this area saw normal to slightly below average temperatures during the forecast period. Slightly above average temperatures were generally confined to the four corners area and eastern New Mexico.

Notes: Figure 15a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months November 2003–January 2004. This forecast was made in October 2003.

The November 2003–January 2004 NOAA CPC outlook predicts the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps described below.

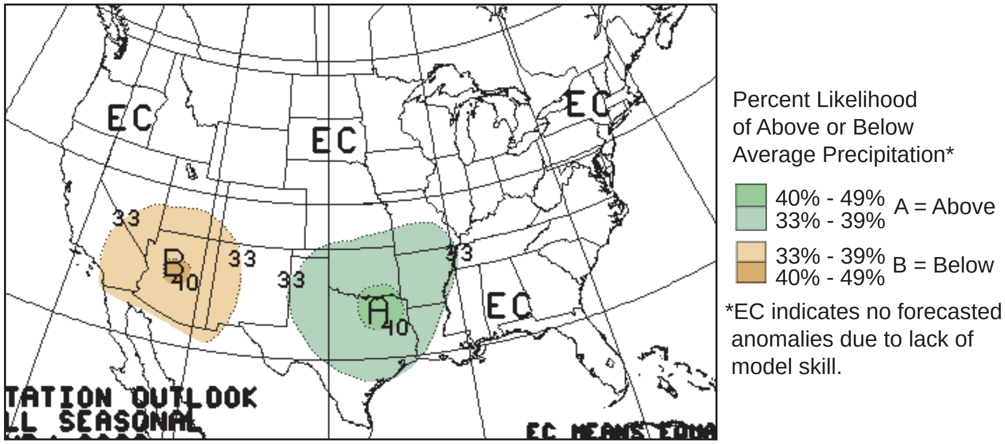
Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average temperature. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3-39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.8-33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 15b shows the observed average temperature between November 2003–January 2004 (°F). Figure 15c shows the observed departure of temperature (°F) from the average for November 2003–January 2004.

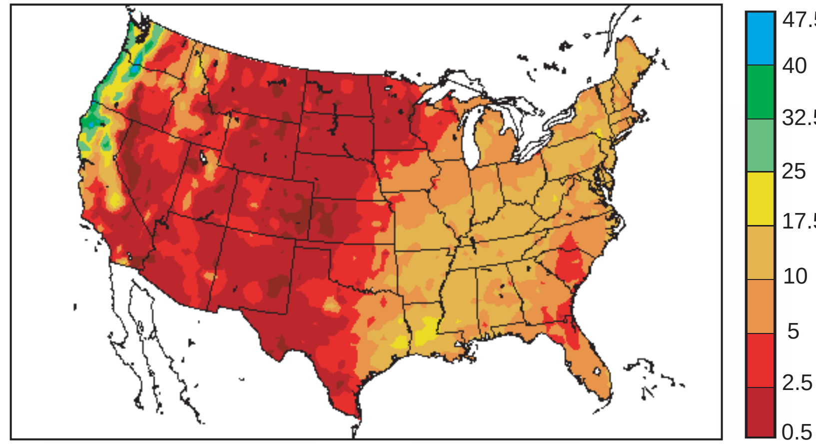
In all of the figures on this page, the term average refers to the 1971-2000 average. This practice is standard in the field of climatology.

16. Precipitation Verification: November 2003–January 2004 ♦ Source: NOAA Climate Prediction Center

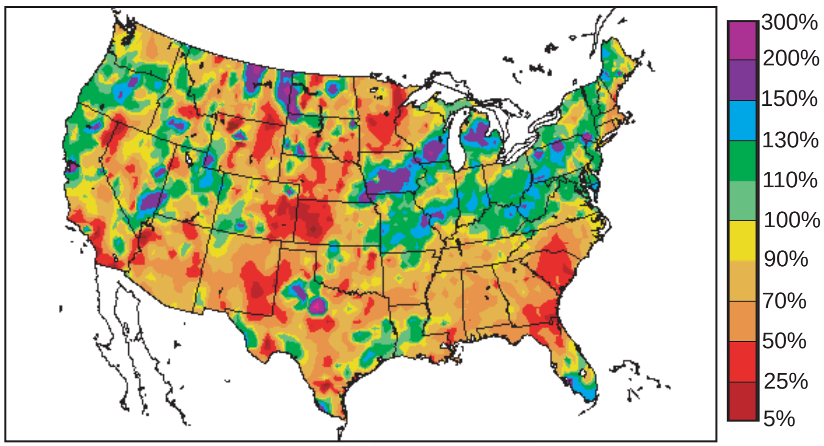
16a. Long-lead U.S. precipitation forecast for November 2003 - January 2004.



16b. Observed precipitation for November 2003 - January 2004 (inches).



16c. Percent of average precipitation observed between November 2003 - January 2004.



Highlights: The NOAA-CPC November–January 2004 precipitation outlook forecasted increased probabilities of below-average precipitation for all of Arizona (Figure 16a). The forecast was correct for Arizona, with precipitation amounts ranging from 25-70 percent for the forecast period. The forecast for above-normal precipitation across eastern Texas, Oklahoma, and Arkansas did not verify well. Precipitation amounts were highly variable across this area but generally below average.

Notes: Figure 16a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months November 2003–January 2004. This forecast was made in October 2003.

The November 2003–January 2004 NOAA CPC outlook predicts the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the forecast map (Figure 16a) do not refer to inches of precipitation. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps described below.

Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average precipitation. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3-39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.8-33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 16b shows the total precipitation observed between November 2003–January 2004 in inches. Figure 16c shows the observed percent of average precipitation for November 2003–January 2004.

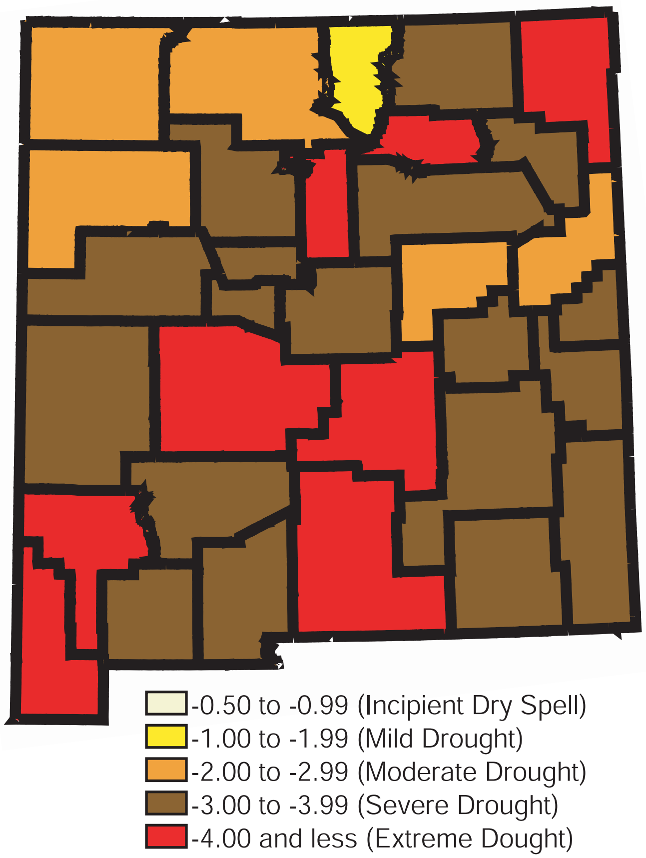
In all of the figures on this page, the term average refers to the 1971-2000 average. This practice is standard in the field of climatology.

Section D

FOCUS ON
PDSI PRODUCTS

17. Focus on National Agricultural Decision Support System Monthly PDSI Product

17. PDSI Map for New Mexico during September 2003



Highlights: For the month of September 2003, most of New Mexico experienced moderate to extreme drought conditions. This analysis was conducted using 139 stations; spline interpolation was used on county-level data using the original PDSI index.

Notes: The University of Nebraska Lincoln provides a collection of decision support tools designed to help agricultural producers access a variety of risks. The National Agricultural Decision Support System includes drought indices such as the Palmer Drought Severity Index (PDSI). This website is accessible at http://www.nadss.unl.edu/index.php. Additional information about the PDSI can be found in the CLIMAS October 2002 END Insight focus pages http://www.ispe.arizona.edu/climas/forecasts/archive/oct2002/swoutlook.html.

To access the PDSI "Quicklink" section, use the link on the left side of the page. To view monthly data, choose a state and click the *monthly data* radio button in the box labeled *Generate a PDSI Report*.

Under *Parameters*, there are a number of options to set to produce PDSI maps for Arizona and New Mexico. For the *end month*, go at least one month back to get enough sample sites. *Interpolation method* refers to how contour lines on the map are created. Each method should produce similar results; however, some methods require more stations. Under *analysis format*, if *table* is used, a table showing values at individual stations will be shown. The analysis format will effect how the interpolation occurs. For example, if the *County-level Map* is used, then the interpolation will use the average value for the county in the interpolation. *Raster maps* are recommended in ordert to increase the geographic specificity of the map.

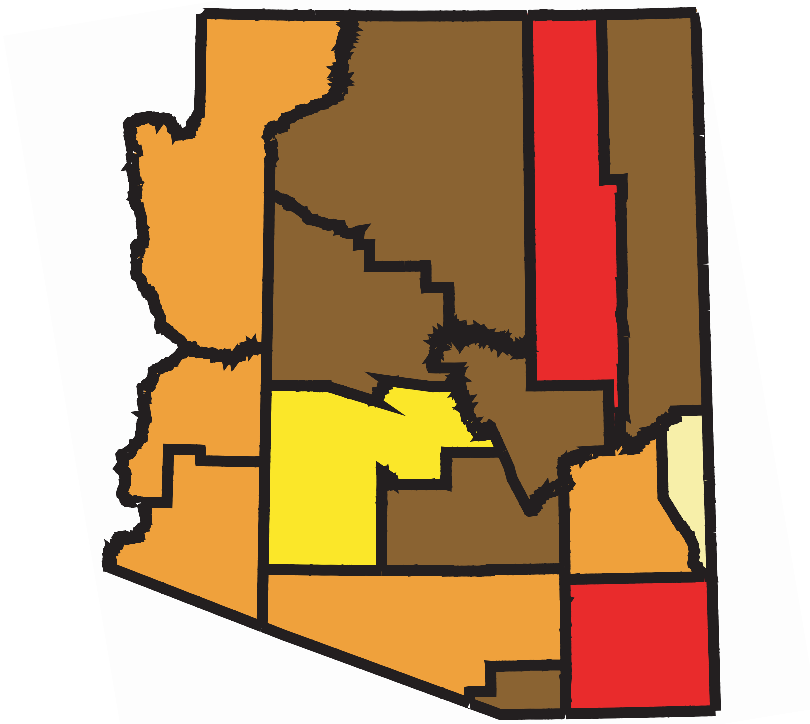
The *overlay* layer allows information to be overlaid on top of the map analysis. For example, to examine what districts might be affected by drought, choose to overlay the congressional districts. To choose multiple overlay layers, hold the "Ctrl" key (Command Key on Macintosh) as selections are made.

To examine specific stations, click on their name from the list. Holding the "Ctrl" key will allow for multiple station selections. *All available sites* are selected by default.

Resolution settings alter the level of detail used in analysis. Using the *low resolution* (3000 m) provides a reasonable level of detail for most analyses. Increasing the resolution will result in longer download times.

18. Focus on National Agricultural Decision Support System Weekly PDSI Product

18. PDSI Map for Arizona between September 10 to September 23, 2003



+0.49 to -0.49 (Near Normal)
-0.50 to -0.99 (Incipient Dry Spell)
-1.00 to -1.99 (Mild Drought)
-2.00 to -2.99 (Moderate Drought)
-3.00 to -3.99 (Severe Drought)
-4.00 and less (Extreme Dought)

Highlights: For the period between September 10 and September 23, 2003, most of Arizona experienced moderate to extreme drought conditions. This analysis was conducted using 135 stations; a spline interpolation method was used on PDSI data.

Notes: The University of Nebraska, Lincoln provides a collection of decision support tools designed to help agricultural producers access a variety of risks. The National Agricultural Decision Support System includes drought indices such as the Palmer Drought Severity Index (PDSI). This website is accessible at http://www.nadss.unl.edu/index.php. Additional information about the PDSI can be found in the CLIMAS October 2002 END Insight focus pages http://www.ispe.arizona.edu/climas/forecasts/archive/oct2002/swoutlook.html.

To access the PDSI *Quicklink* section, use the link on the left side of the page. To view monthly data, choose a state and click the *monthly data* radio button in the box labeled *Generate a PDSI Report*.

Under *Parameters*, there are a number of options to set to produce PDSI maps for Arizona and New Mexico. For the *end month*, go at least one month back to get enough sample sites. *Interpolation method* refers to how contour lines on the map are created. Each method should produce similar results; however, some methods require more stations. Under *analysis format*, if *table* is used, a table showing values at individual stations will be shown. The analysis format will effect how the interpolation occurs. For example, if the *County-level Map* is used, then the interpolation will use the average value for the county in the interpolation. *Raster maps* are recommended in ordert to increase the geographic specificity of the map.

The *overlay* layer allows information to be overlaid on top of the map analysis. For example, to examine what districts might be affected by drought, choose to overlay the congressional districts. To choose multiple overlay layers, hold the “Ctrl” key (Command Key on Macintosh) as selections are made.

To examine specific stations, click on their name from the list. Holding the “Ctrl” key will allow for multiple station selections. *All available sites* are selected by default.

Resolution settings alter the level of detail used in analysis. Using the *low resolution* (3000 m) provides a reasonable level of detail for most analyses. Increasing the resolution will result in longer download times.